Dehcho Boreal Caribou Study Progress Report, April 2009

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Background History

In response to the new federal Species at Risk Act (SARA) and following extensive consultation with the Sambaa K'e Dene Band (SKDB) of Trout Lake, the Department of Environment and Natural Resources (ENR), Dehcho Region initiated an ecological study of boreal caribou in the Trout Lake area during the spring of 2004. SKDB saw the benefits of combining information from this study with their own traditional knowledge study (Yúndíit'qh TEK study) to fill information gaps about boreal caribou, and in supporting the Sambaa K'e Candidate Protected Area. An initial ten female boreal caribou were collared in the Celibeta Lake area in order to document seasonal range use and movements, calving period/locations, and fidelity of seasonal range use over a 4-5 year period. Collared females also provided population information on calf production, calf survival, and adult female survival. Other ecological studies of boreal caribou had been initiated in other regions of the Northwest Territories to increase knowledge of boreal caribou throughout their range (for example Nagy et al. 2005; Johnson 2007), so that in the face of increasing development pressures informed decisions regarding land use could be made.

Snow conditions restricted caribou distribution in 2004. At the request of SKDB, an additional 8 satellite collars were deployed on female boreal caribou in spring 2005. Subsequently, SKDB requested an additional 4 collars be deployed on female boreal caribou in January 2006. Previous annual progress reports of the Trout Lake Caribou Study have been published (Larter and Allaire 2005; 2006a) providing more detailed information.

In response to the requests and after extensive consultations with the Fort Simpson Métis Local (FSML) and Liidlii Kue First Nations (LKFN), ENR Dehcho Region initiated an ecological study of boreal caribou in the Ebbutt Hills area in spring 2005 when 5 satellite collars were deployed on female boreal caribou. The study area included portions of the proposed Mackenzie Gas Pipeline; study objectives were similar to the Trout Lake study. Subsequently, at the requests of Jean Marie River First Nation (JMRFN), Pehdzeh Ki First Nation (PKFN) in Wrigley, and Nahanni Butte Dene Band (NBDB), the Ebbutt Hills study area was expanded and an additional 9 collars (5 satellite and 4 VHF) were deployed in the study area in January 2006. A previous progress report of the Ebbutt Hills Study has been published (Larter and Allaire 2006b) providing more detailed information.

Boreal caribou use the boreal forest without respecting study area or jurisdictional boundaries. Collars have been deployed on female boreal caribou throughout the Dehcho Region with continued support of local First Nations. At the 3rd biannual Dehcho Regional Wildlife Workshop in Fort Simpson (October 2006), Acho Dene Koe Band of Fort Liard expressed interest in having caribou collared in their traditional areas and it was recommended to treat all the boreal caribou work as one large Dehcho study. Subsequently progress reports (Larter and Allaire 2007; 2008) have combined the background information and updates from both studies. This progress report does similarly.

Collar Descriptions

All collars are equipped with a very high frequency (VHF) beacon so they can be relocated from the ground or air with a receiver and antenna system. All collars deployed after March 2004 have a release mechanism programmed for a specific date when the collar simply drops off the animal. VHF and satellite transmissions continue for some time after the collars drop providing the opportunity for ENR staff to retrieve the collar from the field. See Larter and Allaire 2008 for detailed figures of the collars.

Satellite collars (Telonics ST-20) and have been deployed annually from the start of the study; one new generation TAW-4610 was deployed in 2009 (Table 1). All of these collars have been programmed to provide daily locations from 1 May to 14 June (the anticipated calving period) and locations once every 3 days for the remainder of the year with a life span of 3-4 years.

GPS collars (Telonics TGW-3680) have been deployed since January 2007 (Table 1). GPS collars provide 3 locations daily (every 8 hours), with a lifespan of approximately 40 months. These collars provide the most detailed movement and range use information.

VHF collars (Telonics MOD600) were deployed only in January 2006 (Table 1). They do not transmit signals to satellites therefore we must fly to locate them with a receiver and antenna system. These collars are inexpensive and may provide information on adult survival and calf survival/production but provide little information on range use. There are no plans to deploy these collars in future.

Collar Deployments

Collars have been deployed annually since 2004 (Table 1); 69 boreal caribou females from throughout the Dehcho have been fitted with collars (Figs. 1 and 2). All caribou were captured by net-gunning the animal from a helicopter. ENR contracts a professional net-gunning crew to do the work. They must follow strict animal care guidelines (GNWT Animal Care Committee Standard Operating Procedures for handling caribou). Blood, a hair sample (for DNA), and feces are collected from each captured animal as long as the opportunity arises. Prior to 2009, an ear plug was collected for DNA instead of a hair sample. Capture crews deploy in areas requested by First Nations where collared caribou are residing. An aerial fixed-wing reconnaissance was flown immediately prior to the initial capture work in 2004 and 2005. Presently no reconnaissance flights are conducted in order to minimize animal harassment unless at the specific request of First Nations. No animal has been injured during capture operations.

Table 1. The number and type of collars deployed in each year.

Month caribou collared	Satellite (ST-20)	Satellite (TAW-4610H)	GPS (TGW-3680)	VHF (Mod 600)
March 2004	10			
March 2005	13			
January 2006	9			4
January 2007	8		9	
February 2008	4		4	
February 2009		1	7	
TOTAL	44	1	20	4

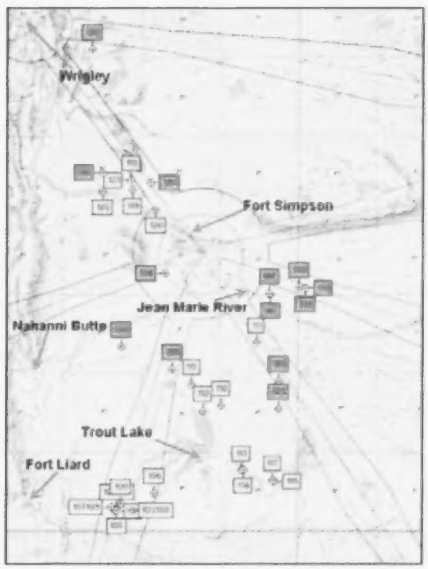

Figure 1. The locations of 36 female boreal caribou collared in , , 2006 (see colour for locations).

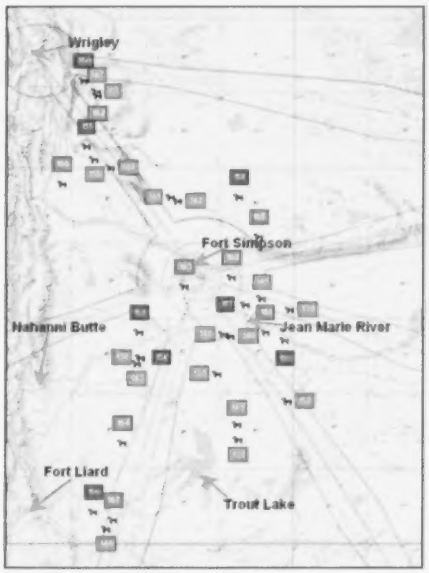

Figure 2. The locations of 33 female boreal caribou collared in 2007, 2008, 2009 (see colour for locations).

Results

Home Ranges

We calculated the 100% minimum convex polygon (a line connecting all of the outside points where a caribou was located) for 49 female caribou equipped with either satellite or GPS collars. All of these females had locations collected over a minimum of 12 months; 25 females had locations collected from ≥24 months (Fig. 3). The mean

home range calculated was 2388km^2 (range 205-7080km^2; median 1829km^2). The range of five caribou included northeastern British Columbia (Fig. 3). Two boreal caribou collared in a northeastern British Columbia study have been located southeast of Trout Lake (Brad Culling pers. comm.) One boreal caribou collared in the Sahtu has been located <50km north of Wrigley (B. Tracz pers. comm.). One caribou (#149 in our study) was originally collared in the Bistcho Lake/Cameron Hills area (Johnson 2007) of a South Slave study. It was re-captured in February 2007 near Trainor Lake and equipped with another collar. We have calculated its range based solely from the locations after it was re-collared (Fig. 4). Home range sizes we report are somewhat smaller than for the Cameron Hills and the Gwich'in study area in the Lower Mackenzie Valley (means of *ca.* 3000km^2; Nagy et al. in prep. a).

Figure 3. Home range estimates (100% minimum convex polygon (MCP)) of 49 collared female boreal caribou. Red is satellite collared caribou, black is GPS collared caribou.

During the calving period, females space out throughout all boreal caribou range (Fig 5). Female boreal caribou remain widely dispersed and found in small groups (1 or 2 adult females) during the post-calving period and throughout the summer (Johnson 2007; Larter and Allaire 2006a; b; Nagy et al. 2005).

Caribou #149

This female was originally collared in the Bistcho Lake/Cameron Hills study area 10 March, 2005 (Fig. 4). She later moved into the Trainor Lake area where she was re-captured and equipped with a new collar February 2007. When including all locations

from both collars, the 100% minimum convex polygon (MCP) estimate for her range is 10,630km^2; 100% MCP of 7082km^2 in Bistcho Lake/Cameron Hills and 100% MCP of 4171km^2 in the Dehcho study area (Fig. 4).

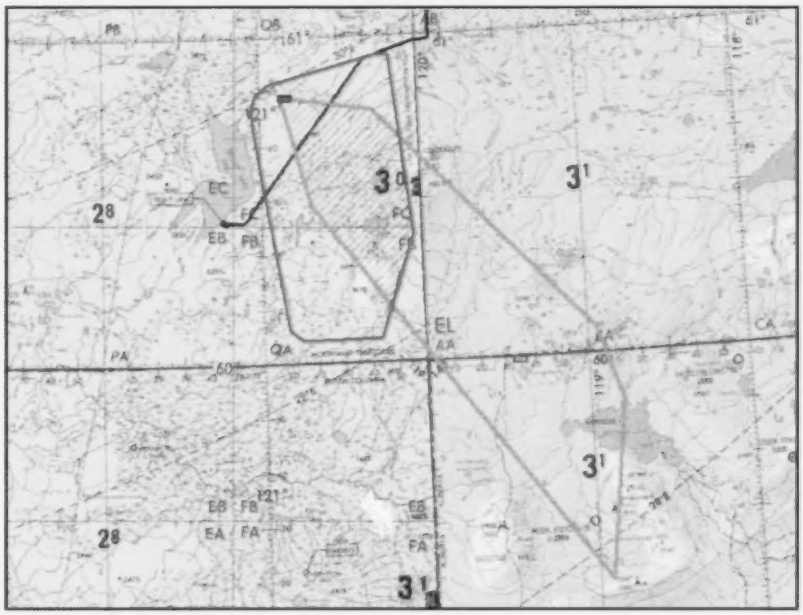

Figure 4. Blue is 100% MCP for locations after 24 February, 2007. Magenta is 100% MCP for locations prior to 24 February, 2007. ▪ initial collar deployment location, 10 March, 2005. ▪ location where she was re-collared, 24 February, 2007.

Figure 5. Calving sites ● of collared female boreal caribou in 2008 showing wide dispersion throughout boreal caribou range.

Movements

Daily movements by female caribou are lowest during calving and drop of dramatically immediately prior to calf drop. We pooled movement data from 108 calving events by caribou equipped with GPS collars in the Dehcho, Bistcho Lake/Cameron Hills, and Gwich'in boreal caribou studies. Average daily movement of GPS collared females dropped from *ca.* 6km/day, 2 days prior to calving, to *ca.* 0.2km/day on calving day and remained at *ca.* 1km/day for about 1 week post-calving (Nagy et al. in prep. b.). This shows that one can determine if and when a collared female had a calf by plotting daily movement data from GPS collared females, potentially eliminating the need to fly out and directly observe whether GPS collared females produced a calf. During the fall/rut period (1 September – 15 October) both group size and daily movements increase as males frequent groups. During early winter (November) and late winter (April) we find the greatest directional movements; movements are greatly reduced during mid-winter (February). Group size is largest during March-April but caribou can still be found in small groups.

Relocation Flights – primarily for VHF collared animals

From 21 April 2008 to 16 February 2009 ten flights were attempted primarily to relocate the three remaining female caribou equipped with VHF collars, with a goal of relocating them each once a month; one relocation was made for caribou #111 from highway #1 on 20 January 2009. The VHF collared animals have ranged over large areas therefore flights with fixed-wing are flown at higher altitude (generally $\geq$3000 feet above ground level); visual observations are rare. Only one VHF collared caribou (#134) was relocated regularly this year; we suspect that the other collars are no longer transmitting. Some opportunistic flights were completed in association with fire operations. We will likely reduce the number of relocation flights in future. See Appendix 1 for a brief account of these flights.

May/June Cow/Calf Surveys

These surveys are conducted with helicopter because their goal is to locate all collared caribou and determine whether or not they have newborn calves with them. All caribou and other wildlife observed on these surveys are recorded (Table 2). This survey provides us with an estimate of annual calf production, but it cannot detect neonatal deaths nor late born calves. This survey sometimes provides the additional opportunity to pinpoint and/or retrieve downed collars. In 2008 we conducted the survey from 28-30 May. We successfully located all caribou with functioning collars in 2006 (n=22), 2007 (n=30), and again in 2008 (n=28). Caribou were widely distributed in all surveys requiring 1900km, 1800km and 2580km of flight lines, respectively. Because the majority of calving occurs from 5-19 May, a combination of survey results with the analysis of movement data during the calving period may provide the most accurate estimate of calf production.

Table 2. Cow/calf survey results from 2006-2008.

	2006	2007	2008
Total number caribou observed	45	74	74
Number of female caribou	27	42	41
Number of calf caribou	16	28	31
Number of calves per 100 female caribou	56.2	66.7	75.6
Number of collared caribou with calves	12	19	24
Number of collared caribou observed	22	30	28
Number of calves per 100 collared female caribou	54.5	63.3	85.7
Number of male caribou	0	2	1
Number of yearling caribou	0	1	0
Number unknown sex/age class caribou	2	1	1
Number of moose observed	2	7	12
Number of black bear observed	1	3	6

February/March Classification Surveys

We assume that calves of the year observed in these late winter surveys are recruited into the population. Surveys are conducted with a helicopter because we need to see all collared caribou and determine the sex/age class of all caribou seen. Photographs of caribou groups are taken to verify the presence of calves. During these surveys we have observed calves with collared caribou that did not have calves with them during the post calving survey of the previous May/June. Most likely these calves were born late or had remained hidden from view in spring. Other wildlife observed on these surveys is also recorded (Table 3). Surveys were completed on 1-2 March, 2006, 26-27 February, 2007, 3-5 March, 2008 and 2-4 March, 2009 with 170, 216, 241 and 291 caribou classified, respectively. We have been fortunate to locate all caribou with properly functioning VHF beacons: 24 in 2006, 33 in 2007, 35 in 2008 and 37 in 2009. During the 2009 survey we observed a non-functioning collar on another caribou in a group we were classifying. This turned out to be caribou #108. Caribou were widely distributed requiring flight lines of approximately 1200km, 1600km, 1700km and 2000km in 2006, 2007, 2008 and 2009, respectively. Caribou were classified into calves (8-10 months old), yearlings (20-22 months old), females ($\geq$32 months old), and males ($\geq$32 months old). Some yearlings may have been misclassified as females or males $\geq$32 months old.

Eight of 11 collared female caribou (72.7%) that we know had calves in May 2005 (based upon a limited fixed-wing survey) were seen with calves in the March 2006 survey. Six of 13 collared female caribou (46.2%) that we know had calves in May 2006 were seen with calves in the February 2007 survey. Eight of 21 collared female caribou (38.0%) that we know had calves in May 2007 were seen with calves in the March 2008 survey. Thirteen of 25 collared female caribou (52.0%) that we know had calves in May 2008 were seen with calves in the March 2009 survey. The number

of calves per 100 adult females that we report in February/March is slightly higher than that reported for caribou in the adjacent Bistcho Lake/Cameron Hills study area (Johnson 2007), but much lower than that reported for caribou in Gwich'in study area in the Lower Mackenzie Valley. Wolf predation on boreal caribou in the Lower Mackenzie Valley is negligible unlike in the Bistcho Lake/Cameron Hills and Dehcho study areas (Johnson 2007; J. Nagy pers. comm.). Now we have had collared caribou distributed widely throughout the Dehcho region for over four years, there is some indication that population characteristics may be different for caribou that were collared north of the Mackenzie River from those collared south of the Mackenzie River.

Table 3. The number of caribou classified and other wildlife observed during caribou sex/age classification surveys in 2006-2009.

	2006	2007	2008	2009
Total number caribou observed	170	216	241	291
Number of female caribou	94	114	145	160
Number of calf caribou (8-10 months old)	27	26	34	50
Number of yearling caribou (20-22 months old)	13	6	1	1
Number of male caribou	35	70	61	80
Number unknown sex/age class caribou	1	0	0	0
Number of calves per 100 female caribou	28.7	22.8	23.4	31.3
Number of moose observed	18	38	15	31
Number of wolves observed	2	1	0	0

Mortalities

From 1 April 2008 to 31 March 2009, six collared caribou died and two other collars released/ceased to function. We retrieved two collars, which were mortalities; one predated, one harvested. Four other known mortalities we were unable to retrieve, one of these collars went underwater and could not be relocated. Two collars released from caribou and we were unable to relocate VHF collar #133 after December 2008.

To date there have been 28 mortalities of collared caribou. There is strong evidence that 20 (71%) resulted from wolf predation and 1 resulted from bear predation; 2 caribou were harvested, 2 died of causes likely associated with old age, and three collars have yet to be retrieved so cause of death is currently unknown. The majority (n=23; 82%) of mortalities occur between late-March and mid-July in any year, a similar time period when the majority of female mortalities have occurred in the Bistcho Lake/Cameron Hills study area (Johnson 2007). Other mortalities occurred in August (n=1), September (n=1), October (n=1) and November (n=2). Some mortalities occurred near prominent game trails not associated with seismic activity.

Teeth have been retrieved from 11 of the 27 mortalities and forwarded to Matson's Lab for aging. Age is determined based upon counting cementum annuli on preferably

the incisor teeth, similar to counting the rings of a tree. 1 June is used as the birth date for caribou (Matson 1981). The age range is from 5 to 17 (median age 10 years; Fig. 6). These are some surprising old ages. Also of note is that blood test results indicated that 5 of the collared female caribou were pregnant at 10, 10, 14, 14, and 16 years of age.

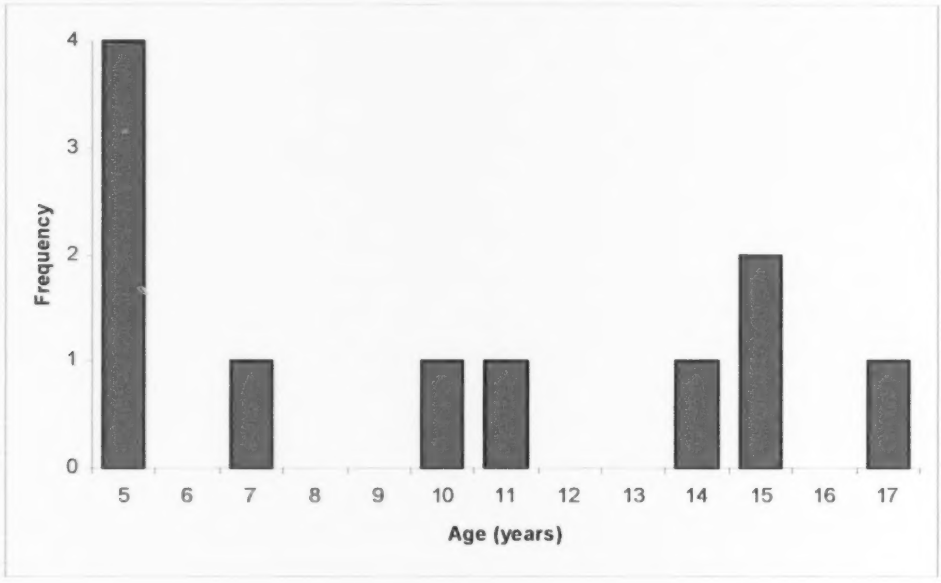

Figure 6. The ages of 11 female boreal caribou at the time of their death rounded down to the nearest year. Age determined by counting cementum annuli of teeth.

Adult Female Survival

Based upon the number of collared caribou that have died during the course of the study to date (Kaplan and Meier 1958; Pollock et al. 1989) our best estimate of mean adult survival over 4 years pooled across the entire study area is 76%. There has been yearly variation in adult female survival and there may be an indication that population demographics are somewhat different for caribou collared north of the Mackenzie River compared to caribou collared south of the Mackenzie River (Table 4.) Overall throughout the Dehcho, adult female survival tends to be low and less than that reported in the Bistcho Lake/Cameron Hills (Johnson 2007) and Gwich'in (Nagy et al. 2005) study areas.

Estimated Population Rate of Increase

We estimated the population rate of increase measured from 1 April to 31 March for 4 successive years from all caribou collared throughout the entire study area. We also made separate estimates from caribou collared north and south of the Mackenzie River.

We based the estimate on the annual female survival and the ratio of calves per 100 adult females of collared animals (Hatter and Bergerud 1991). A rate of increase, or λ, of 1 indicates population stability, < 1 indicates population decrease, and > 1 indicates population increase. Small sample sizes affect the confidence of the estimate, but λ values have generally been < 1 (Table 4).

Table 4. The population rate of increase (λ) estimated for 4 successive years in the Dehcho. South is calculated from caribou originally collared south of the Mackenzie River, north from caribou originally collared north of the Mackenzie River.

South Dehcho

Year	Female Survival Rate	Ca:100 Females	Rate of Increase (λ)
2005-2006	0.6250	0.2587	0.7179
2006-2007	0.6429	0.2616	0.7396
2007-2008	0.9375	0.2558	1.0750
2008-2009	0.7391	0.4444	0.9503

North Dehcho

Year	Female Survival Rate	Ca:100 Females	Rate of Increase (λ)
2005-2006	0.6000	0.3318	0.7193
2006-2007	0.7500	0.1999	0.8333
2007-2008	0.8125	0.1937	0.8996
2008-2009	1.0000	0.3333	1.2000

Dehcho Combined

Year	Female Survival Rate	Ca:100 Females	Rate of Increase (λ)
2005-2006	0.6191	0.2881	0.7232
2006-2007	0.6923	0.2286	0.7817
2007-2008	0.8750	0.2335	0.9906
2008-2009	0.7857	0.3611	0.9588

Response to Anthropogenic Linear Features

Recent analyses of location data obtained for boreal caribou outfitted with GPS collars in the Gwith'in, Dehcho, and Bistcho Lake/Cameron Hills study areas indicate that seismic lines affect movements of caribou. Caribou use areas near seismic lines less than if they were wandering around. Caribou show reduced use of areas near seismic lines as the density of seismic lines increased within their home ranges (Nagy et al. in prep. a). Caribou also travel faster when they do cross seismic lines, but they cross seismic lines less frequently than expected if they were randomly wandering around within their home ranges (Nagy et al. in prep. a). For caribou in stable or increasing populations, $< 20\%$ of their annual home ranges were within 250m of linear developments and the density of seismic lines in their annual home ranges was < 0.5km per km^2 (Nagy et al. in prep. a.).

Although the Dehcho is relatively pristine, the Dehcho Land Use Plan (DLUP) indicates a noticeable linear footprint on the landscape. Based upon the DLUP digital linear footprint files we calculated the distance of the 28 caribou mortalities from the nearest linear feature. Seismic lines do not kill caribou, predators that travel these lines do. Of 21 mortalities related to wolf or bear predation, 7 (33%) occurred $\leq$500m from a linear feature (Table 5.). The two harvested caribou were also located $\leq$500m from a linear feature. The 2 animals whose death was not related to predation died 150 and 200m from the nearest linear feature. There is a much higher impact of predators in the Dehcho than the Gwich'in study area likely because there is a diversity and abundance of other prey species. A greater number of predators traveling the same amount of linear features would have more of an impact on the caribou population. This may be why the caribou population(s) in the Dehcho show a λ indicating population decrease.

Table 5. The number of caribou mortalities, related to wolf or bear predation, found at various distances (metres) from the nearest linear feature. The linear features are based upon the DLUP linear footprint.

Distance from DLUP Linear Feature (m)	<100	100-250	251-500	501-1000	>1000
Number	2	3	2	5	9

Disease and Parasites

Blood and fecal samples collected from this study and from the Bistcho Lake/Cameron Hills study have been analyzed for the presence of diseases and parasites (Johnson et al. in prep.). Samples from this study only indicate minor infestations of the eggs of *Ostertagia* which have been found in 50 of 93 (54%) fecal samples. Two fecal samples had eggs of *Moniezia* and one fecal sample had eggs of lungworm (*Parelaphostrongylus* spp.). *Giardia* and *Cryptosporidium* eggs have been found in 3 (3%) and 2 (3%) of 93 fecal samples, respectively. All 22 blood samples were negative for *Brucella*, with 6 (27%) indicating exposure to herpesvirus.

Miscellaneous Topics and Findings of Note

Calving Fidelity

Some female caribou certainly show fidelity to calving areas by calving in roughly the same location in successive years, but that is not the case for all collared females.

Collar Issues

We located one of two caribou equipped with collars deployed in spring 2004. Both collars had ceased to transmit satellite and VHF transmissions and were not outfitted

with release mechanisms. Caribou #108 was in a group with caribou #146 located south of Celibeta Lake within her home range. We checked to make sure that the collar was not on an animal collared in northeastern British Columbia. This was an important find for estimating adult female survival.

Eight of the collars deployed in spring 2005 started to give infrequent intermittent signals during winter indicating that they were near the end of their battery life. This was prior to the estimated end of life. Some of these collars had been on animals that had spent much more time in heavily timbered areas of the study area. This may have contributed to a decreased battery life as they had to transmit longer before getting a fixed location. Fortunately they began transmitting again in late winter as temperatures rose and some gave transmissions during the abnormally warm weather in January. These collars are scheduled to release in March/April 2009.

Another of the collars deployed in spring 2005 had been providing intermittent transmissions for over a year. Telonics provided us with a replacement collar (a new generation TAW-4610H that was deployed in February 2009.

The life span of collars deployed in 2005 and 2006 is nearing an end. We will have at least 12 satellite collars releasing from caribou during March-April 2009, with additional satellite collars scheduled to release during June-September 2010. We will attempt to retrieve as many of these collars as is logistically feasible so they can be refurbished and made available for redeployment. The loss of these collars will substantially reduce the number of collared female caribou in the study. In order for continued population monitoring we would need to maintain a minimum number of collared females. GPS collars provide movement data that can determine calving events, thus reducing the need for helicopter survey of GPS collared females. Therefore, it would be wise to ensure that any additional collars required, to maintain an adequate sample size for population monitoring, should be GPS collars if at all possible. At the 4th biannual Dehcho Regional Widlife Workshop a minimum of 30 collars being maintained throughout the study area was suggested. There was some concern that if there was indeed evidence of population differences for caribou north and south of the Mackenzie River, 30 collars in total might not be enough. First Nations delegates were highly supportive of the Dehcho Boreal Caribou study and the need for continued population monitoring. The delegates indicated that continued community consultations would be required in order to provide direction for future collar deployment.

Co-operative Work Projects

Over the past 3 winters Sambaa K'e Dene Band (SKDB) has conducted a track count study. ENR assisted with the initial stages of the study. Caribou and wolf fecal samples have been collected opportunistically during this study. SKDB has made these samples available to ENR. Some of these additional samples have been used for disease and parasite analysis (Johnson et al. in prep.). ENR and SKDB have a co-operative data

sharing agreement that provides location information from caribou residing in the track count study area.

All location data from this study has been incorporated with data from the Gwich'in and Bistcho Lake/Cameron Hills studies into a territorial-wide analysis. The various analyses include resource selection models and detailed movement data to assess how boreal caribou use their range seasonally and how caribou use the range in relation to different current levels of disturbance throughout the range of boreal caribou in the Northwest Territories (Nagy et al. in prep c; d). We continue to work co-operatively with the researchers conducting these boreal caribou studies.

Deliverables

ENR provides an annual progress report of Dehcho boreal caribou to its First Nations partners and to the Biophysical Program, which is posted on the ENR website. ENR continues to provide quarterly maps to its First Nations partners. The maps show the ranges used by each individual collared caribou over the previous 3 months.

John Nagy (ENR Yellowknife) has made presentations on the territorial-wide analyses at the 4th biannual Dehcho Regional Wildlife Workshop, October 2008, and to the members of the science advisory group for the identification of critical habitat for boreal caribou in Ottawa, April 2009.

A presentation of the program and its recent findings was made at the Dehcho Naxehcho (Elders) and Harvesters Gathering in Hay River.

Scientific manuscripts on various aspects of the study are being drafted and we anticipate them being submitted for journal publication during the coming year.

Posters outlining the Dehcho boreal caribou program and preliminary results were presented at the Science in the Changing North Conference in Yellowknife and at the 11th North American Caribou Conference held in Jasper, Alberta.

Acknowledgements

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Wildlife, the Western Northwest Territories Biophysical Study (GNWT), Canadian Wildlife Service and the Cumulative Impact Monitoring Program (DIAND).

Personal Communications

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Appendix 1. Brief descriptions of relocation and collar retrieval flights conducted since from April 2008 to March 2009.

All relocation flights.

- 21 April, fixed-winged aircraft to relocate #132,134,143, and 159.
- 9 May, fixed-winged aircraft to relocate #134; unable to relocate 132 & 133.
- 28-30 May, helicopter to relocate and get visual observations of 28 of 32 caribou with functioning collars. Made visual observations of collars by the remains of caribou #129 and 150. Unable to get a VHF signal at the last known satellite location of 142, and there was too much static to locate 160.
- 30 June, fixed-winged aircraft to relocate #112 & 134.
- 11 August, fixed-winged aircraft to relocate #134; unable to relocate 132 or 143 (which is not transmitting satellite signals).
- 24 September, fixed-wing aircraft to relocate #134 & 143.
- 30 October, fixed-wing aircraft to relocate #134 & 143.
- 22 and 24 November, a fixed-winged aircraft to relocate 111, 112, 114, 115, 116,134 and 143, all collars had recently stopped satellite transmissions.
- 20 January, relocated #111 from the road near Checkpoint.
- 16 February, fixed-winged aircraft to relocate #111, 112, & 134; unable to relocate #143.
- 2-4 March, helicopter to relocate and get visual observations of 37 animals with active collars and conduct a sex/age classification survey.

All flights to retrieve collars from dead animals.

- 28 May, helicopter to try and locate a downed collar #142; unable to get signal, likely fell into water during spring.
- 29 May, helicopter to retrieve the collar #129.
- 17 June, retrieved collar #150 off Highway #7 just north of the N'dulee. Collar separate from kill site, likely a hunter shot the caribou and left collar.

Appendix 2. A time line of each collared caribou since 2004. The collar type (GPS, Sat = Satellite, VHF) is noted as well as whether most recently only VHF signals are being received.

Animal #168 (GPS)
- 19 Feb/09 collared
- 2 March/09 seen in group of 5 without calf

Animal #167 (GPS, suspect died)
- 18 Feb/09 collared
- 3 March/09 seen in group of 7 without calf
- 21 March locations became stationary, suspect mortality

Animal #166 (GPS)
- 19 Feb/09 collared
- 2 March/09 seen in group of 10 with #155 without calf

Animal #165 (GPS)
- 19 Feb/09 collared with calf
- 2 March/09 seen in group of 14 with calf

Animal #164 (GPS)
- 18 Feb/09 collared
- 3 March/09 seen in group of 4 without calf

Animal #163 (GPS)
- 19 Feb/09 collared
- 3 March/09 seen in group of 9 without calf

Animal #162 (GPS)
- 19 Feb/09 collared
- 2 March/09 seen in group of 11 without calf

Animal #161 (Sat)
- 18 Feb/09 collared
- 2 March/09 seen in group of 5 without calf

Animal #160 (Sat)
- 17 Feb/08 collared with calf
- 3 March/08 seen in group of 5 with calf
- 28 May/08 no visual, too much static
- 2 March/09 seen in group of 14 without calf

Animal #159 (Sat)
- 16 Feb/08 collared
- 4 March/08 seen in group of 24 without calf
- 21 April/08 located with 134
- 28 May/08 seen without calf
- 3 March/09 seen in group of 8 without calf

Animal #158 (Sat)
- 17 Feb/08 collared
- 3 March/08 seen with cow
- 28 May/08 seen with calf
- 2 March/09 seen in group of 6 with calf

Animal #157 (Sat, only VHF active)
- 17 Feb/08 collared
- 3 March/08 seen in group of 5 without calf
- 23 May/08 lost satellite signal
- 29 May/08 seen in group of 3 with calf
- 2 March/09 seen in group of 5 with calf

Animal #156 (GPS)
- 18 Feb/08 collared with calf
- 4 March/08 seen in group of 4 with calf
- 29 May/08 seen without calf
- 3 March/09 seen in group of 14 with calf

Animal #155 (GPS)

- 17 Feb/08 collared
- 3 March/08 seen in group of 6 without calf
- 28 May/08 seen with calf
- 2 March/09 seen in group of 10 with #166 without calf

Animal #154 (GPS)

- 17 Feb/08 collared
- 5 March/08 seen in group of 19 without calf
- 29 May/08 seen with calf
- 4 March/09 seen in group of 5 with calf

Animal #153 (GPS)

- 16 Feb/08 collared with calf
- 4 March/08 seen in group of 4 without calf
- 29 May/08 seen without calf
- 2 March/09 seen in group of 5 with calf

Animal #152 (GPS)

- 23 Jan/07 collared
- 27 Feb/07 seen in group of 6 without calf
- 30 May/07 seen with calf
- 4 March/08 seen with cow
- 30 May/08 seen with calf
- 3 March/09 seen in group of 10 without calf

Animal #151 (died, GPS not retrieved)

- 22 Jan/07 collared
- 26 Feb/07 seen in group of 6 without calf
- 29 May/07 seen with calf
- 3 March/08 seen in group of 8 without calf
- 28 May/08 seen with calf
- Died 8-10 Aug/08 by Fish Lake

Animal #150 (died, GPS)

- 22 Jan/07 collared
- 26 Feb/07 seen in group of 2 without calf
- 29 May/07 seen with calf
- 3 March/08 seen with cow
- Died 26-28 May/08 likely shot by harvester
- 17 June/08 collar retrieved

Animal #149 (GPS)

- 24 Feb/07 collared
- 27 Feb/07 seen in group of 7 without calf
- 30 May/07 seen with calf
- 4 March/08 seen in group of 10 without calf
- 29 May/08 seen with calf
- 3 March/09 seen in group of 9 with calf

Animal #148 (Sat)

- 24 Jan/07 collared
- 26 Feb/07 seen in group of 12 without calf
- 30 May/07 seen without calf
- 4 March/08 seen with calf
- 29 May/08 seen with calf
- 2 March/09 seen in group of 3 without calf

Animal #147 (died, Sat not retrieved)

- 22 Jan/07 collared
- 26 Feb/07 seen in group of 8 without calf
- 30 May/07 seen without calf
- 3 March/08 seen in group of 9 without calf
- 28 May/08 seen with calf
- Died 20-26 June/08

Animal #146 (Sat, only VHF active)

- 21 Jan/07 collared
- 27 Feb/07 see in group of 11 with calf
- 30 May/07 seen with calf

- 4 March/08 seen in group of 4 with calf
- 29 May/08 seen without calf
- 2 July/08 lost satellite signal
- 3 March/09 seen in group of 3 with #108 without calf

Animal #145 (Sat, only VHF active)

- 21 Jan/07 collared
- 27 Feb/07 seen in group of 3 without calf
- 30 May/07 seen without calf
- 3 March/08 seen in group of 4 with calf
- 29 May/08 seen with calf
- 2 July/08 lost satellite signal
- 2 March/09 seen in group of 5 with calf

Animal #144 (died, Sat)

- 23 Jan/07 collared
- 26 Feb/07 seen in group of 10 without calf
- Died 5-6 April/07 shot by WY chief
- 12 April/07 collar retrieved

Animal #143 (Sat, only VHF active)

- 21 Jan/07 collared
- 26 Feb/07 seen in group of 6 without calf
- 29 May/07 seen with calf
- 20 Nov/07 seen in group of 4
- 04 Sept/07 lost satellite
- 4 March/08 seen in group of 6 without calf
- 26 March/08 located, no visual
- 21 April/08 located, no visual
- 29 May/08 not located, no signal
- 3 March/09 seen in group of 2 without calf

Animal #142 (Sat, unknown status)

- 22 Jan/07 collared
- 26 Feb/07 seen in group of 10 without calf
- 29 May/07 seen with calf
- 3 March/08 seen in group of 4 without calf
- Died before 9 May/08
- 28 May/08 went to last known satellite location but no VHF transmission, likely underwater

Animal #141 (died, Sat)

- 23 Jan/07 collared
- 26 Feb/07 seen in group of 2 without calf
- Died 27-31 May/07
- 13 July/07 collar retrieved

Animal #140 (died, GPS)

- 24 Jan/07 collared
- 26 Feb/07 seen in group of 3 without calf
- 30 May/07 seen without calf
- Died 30 Oct-4 Nov/07
- April 25/08 collar retrieved

Animal #139 (GPS)

- 21 Jan/07 collared
- 27 Feb/07 seen in group of 6 without calf
- 30 May/07 seen in group of 4 with calf
- 3 March/08 seen with calf
- 29 May/08 seen with calf
- 2 March/09 seen in group of 3 without calf

Animal #138 (GPS)

- 23 Jan/07 collared
- 27 Feb/07 seen in group of 4 without calf
- 30 May/07 seen without calf
- 4 March/08 seen in group of 8 without calf
- 29 May/08 seen with calf
- 3 March/09 seen in group of 17 without calf

Animal #137 (GPS)

- 23 Jan/07 collared
- 27 Feb/07 seen in group of 5 without calf
- 29 May/07 seen with calf
- 5 March/08 seen with calf
- 29 May/08 seen in group of 3 with calf
- 3 March/09 seen in group of 13 with calf

Animal #136 (GPS)

- 23 Jan/07 collared
- 26 Feb/07 seen in group of 5 without calf
- 29 May/07 seen without calf
- 5 March/08 seen in group of 19 without calf
- 29 May/08 seen with calf
- 7 March/09 seen in group of 7 without calf

Animal #135 (died, VHF)

- 21 Jan/06 collared
- 1 March/06 seen in group of 4 without calf
- 30 May/06 without calf
- 28 Sept/06 no visual
- 23 Feb/07 seen in group of 6 without calf
- Died 23-28 May/07
- 31 May/07 collar retrieved

Animal #134 (VHF)

- 21 Jan/06 collared
- 1 March/06 seen in group of 3
- 29 May/06 seen with calf
- 16 Sept/06 seen in group of 4
- 26 Feb/07 seen in group of 2 without calf
- 29 May/07 seen without calf
- 15 Feb/08 seen in group of 13 without calf
- 4 March/08 seen in group of 24 without calf
- 26 March/08 located, no visual
- 21 April/08 located with 159
- 28 May/08 seen with calf
- 3 March/09 seen in group of 9 with calf

Animal #133 (VHF, unknown status)

- 21 Jan/06 collared
- 1 March/06 seen with calf
- 30 May/06 seen with calf
- 23 Jan/07 seen in group of 10 without calf
- 26 Feb/07 seen in group of 3 without calf
- 29 May/07 seen with calf
- Unable to relocate since Dec/08

Animal #132 (released VHF not retrieved)

- 22 Jan/06 collared
- 1 March/06 seen in group of 9 with calf
- 29 May/06 approx. location not pregnant
- 16 Sept/06 seen in group of 2 without calf
- 26 Feb/07 seen in group of 3 without calf
- 30 May/07 seen with calf
- 15 Feb/08 seen in group of 5 without calf
- 4 March/08 seen in group of 5 without calf
- 26 March/08 located, no visual
- 21 April/08 located, no visual
- 29 May/08 not located, unable to relocate since 21April/08
- 1 March/09 programmed to release from caribou
- 2 March/09 located collar in mortality mode, no caribou seen

Animal #131 (Sat)

- 22 Jan/06 collared
- 1 March/06 seen with calf
- 29 May/06 without calf

- 16 Sept/06 seen in group of 3 cows without calf
- 21 Jan/07 seen in group of 5 with calf
- 27 Feb/07 seen in group of 5 without calf
- 30 May/07 seen with calf
- 03 March/08 seen in group of 8 with calf
- 29 May/08 seen with calf
- 2 March/09 seen in group of 4 with calf

Animal #130 (died, Sat)
- 22 Jan/06 collared
- 1 March/06 seen in group of 7 without calf
- 29 May/06 without calf
- Died 1-7 July/06
- 23 Aug/06 collar retrieved

Animal #129 (died, Sat)
- 20 Jan/06 collared
- 1 March/06 seen in group of 6 without calf
- 30 May/06 seen with calf
- 16 Sept/06 with calf
- 21 Jan/07 seen in group of 4 with calf
- 26 Feb/07 seen in group of 10 with calf
- 29 May/07 seen with calf
- 05 March/08 seen without calf
- Died 18-22 May/08
- 29 May/08 collar retrieved

Animal #128 (Sat, only VHF active)
- 20 Jan/06 collared
- 2 March/06 seen in group of 5 without calf
- 30 May/06 seen in group of 4 with calf
- 16 Sept/06 seen in group of 3 without calf
- 27 Feb/07 seen in group of 5 without calf
- 29 May/07 seen with calf
- 04 March/08 seen in group of 10 with calf
- 29 May/08 seen with calf
- 22 Oct/08 collar finished transmitting
- 3 March/09 seen in group of 3 with calf

Animal #127 (died, Sat)
- 22 Jan/06 collared
- 1 March/06 seen in group of 7 with calf
- 29 May/06 seen with calf
- Died 1-5 July/06, likely wolf predation
- 16 Sept/06 confirm carcass
- 23 Oct/06 collar retrieved

Animal #126 (Sat)
- 21 Jan/06 collared
- 1 March/06 seen in group of 5 with yearling
- 30 May/06 seen with calf
- 26 Feb/07 seen in group of 13 without calf
- 29 May/07 seen without calf
- 03 March/08 seen in group of 14 without calf
- 28 May/08 seen with calf
- 2 March/09 seen in group of 5 without calf

Animal #125 (died, Sat)
- 22 Jan/06 collared
- 1 March/06 seen in group of 16 with yearling
- 29 May/06 seen with small calf
- Died 12-15 July/06, likely wolf predation
- 16 Sept/06 no visual
- 23 Oct/06 collar retrieved

Animal #124 (died, Sat)
- 20 Jan/06 collared

- 2 March/06 seen in group of 7 without calf
- Died 13-19 May/06, likely wolf predation
- 23 Aug/06 collar retrieved

Animal #123 (died, Sat)
- 20 Jan/06 collared
- 2 March/06 seen in group of 4 with calf
- 29 May/06 without calf
- 16 Sept/06 seen in group of 3
- Died 1-5 Nov/06 on Trainor Lake
- 15 Feb/07 locate collar in ice
- 27 Feb/07 collar retrieved

Animal # 122 (Sat, unknown status)
- 4 March/05 collared
- 21 March/05 seen in group of 3
- 30 March/05 seen in group of 3
- 1 June/05 seen alone without calf
- 4 June/05 no visual
- 23 Sept/05 no visual
- 10 Oct/05 no visual
- 31 Nov/05 no satellite signal
- 4 April/05 got satellite signal back
- 30 May/05 seen without calf
- 24 Nov/06 no satellite signal
- 15 June/07 collar went off air finishing transmissions

Animal #121 (died, Sat)
- 4 March/05 collared
- 21 March/05 seen in group of 3
- Died 26-27 March predated by wolves
- 30 March/05 collar retrieved

Animal #120 (Sat, only VHF active)
- 4 March/05 collared
- 21 March/05 seen in group of 13
- 30 March/05 seen in group of 3
- 1 June/05 no visual
- 4 June/05 seen alone without calf
- 23 Sept/05 seen in group of 14
- 10 Oct/05 no visual
- 16 Jan/06 seen in group of 3
- 1 March/06 seen in group of 5
- 30 May/06 without calf
- 26 Feb/07 seen in group of 10 without calf
- 30 May/07 seen without calf
- 7 Dec/07 seen in group of 4 without calf
- 3 March/08 seen in group of 4 without calf
- 28 May/08 seen with calf
- 7 Oct/08 collar finished transmitting
- 2 March/09 see in group of 6 without calf

Animal # 119 (Sat, only VHF active)
- 4 March/05 collared
- 21 March/05 seen in group of ≥ 8
- 30 March/05 no visual
- 1 June/05 seen alone without calf
- 23 Sep/05 no visual
- 10 Oct/05 no visual
- 16 Jan/06 in group of 5 without calf
- 1 March/06 in group of 4
- 30 May/06 with calf
- 22 Jan/07 in group of 3 with calf
- 26 Feb/07 in group of 11 with calf
- 29 May/07 seen without calf
- 3 March/08 seen with cow
- 28 May/08 seen with calf
- 10 Sept/08 collar finished transmitting
- 2 March/09 seen in group of 5 without calf

Animal # 118 (died, Sat)

- 4 March/05 collared
- 21 March/05 seen in group of 10
- 30 March/05 seen in group of 9
- 1 June/05 no visual
- 4 June/05 no visual
- Died 15-21 June/05, likely wolf predation
- 6 Sept/05 collar retrieved

Animal #117 (died, Sat)

- 3 March/05 collared
- 10 April/05 not checked on
- 5 May/05 not checked on
- 31 May/05 seen alone without calf
- 10 June/05 seen in thick brush
- 23 September/05 seen in group of at least 4
- 5 Oct/05 not checked on
- 26 Jan/06 seen in group of 4 with calf
- 2 March/06 seen in group of 5 with calf
- Died 17-21 April/06
- 28 Aug/06 collar retrieved

Animal #116 (Sat, only VHF active)

- 3 March/05 collared
- 10 April/05 not checked on
- 5 May/05 not checked on
- 31 May/05 seen alone without calf
- 10 June/05 no visual
- 23 Sept/05 seen in group of 3
- 5 Oct/05 not checked on
- 26 Jan/06 seen in group of 7 with calf
- 2 March/06 seen in group of 4 with calf
- 29 May/06 seen with calf
- 16 Sept/06 seen in group of 2 without calf
- 23 Jan/07 seen in group of 12 without calf
- 27 Feb/07 seen in group of 6 without calf
- 30 May/07 seen in group of 3 with calf
- 4 March/08 seen with bull
- 29 May/08 seen with calf
- 13 Oct/08 collar stopped satellite transmissions
- 3 March/09 seen in group of 17 without calf

Animal #115 (Sat, only VHF active)

- 3 March/05 collared
- 10 Apr/05 seen in group of 3
- 5 May/05 not checked on
- 31 May/05 seen alone without calf
- 10 June/05 not checked on
- 23 Sept/05 no visual
- 5 Oct/05 seen in group of 2 without calf
- 2 March/06 seen in group of 9 without calf
- 30 May/06 seen in group of 2 without calf
- 16 Sept/06 seen in group of 4 without calf
- 27 Feb/07 seen in group of 4 without calf
- 29 May/07 seen with calf
- 04 March/08 seen with 2 cows
- 30 May/08 seen with calf
- 1 Oct/08 collar stopped satellite transmissions
- 4 March/09 seen in group of 3 with calf

Animal #114 (Sat, only VHF active)

- 3 March/05 collared
- 10 April/05 seen in group of 9
- 5 May/05 not checked on
- 31 May/05 no visual
- 10 June/05 seen alone without calf
- 23 Sept/05 no visual
- 5 Oct/05 not checked on

- 2 March/06 seen in group of 6 without calf
- 29 May/06 seen in group of 3 without calf
- 16 Sept/06 seen in group of 3 without calf
- 27 Feb/07 seen in group of 6 without calf
- 30 May/07 seen with without calf
- 4 March/08 seen in group of 7 without calf
- 29 May/08 seen with calf
- 3 July/09 collar stopped satellite transmissions
- 3 March/09 seen in group of 13 with calf

Animal #113 (died, Sat)

- 3 March/05 collared
- 10 April/05 seen in group of 4
- 5 May/05 not checked on
- 31 May/05 no visual
- 10 June/05 seen alone without calf
- Died 2-8 Sept/05 likely wolf predation
- 5 Oct/05 collar retrieved

Animal #112 (unk, Sat, only VHF active)

- 3 March/05 collared
- 10 April/05 seen with calf
- 5 May/05 not checked on
- 31 May/05 seen with calf
- 10 June/05 seen with calf
- 23 Sept/05 no visual
- 5 Oct/05 not checked on
- 1 March/06 seen in group of 6 with calf
- 30 May/06 seen in group of 4 with calf
- 16 Sept/06 seen with calf
- 27 Feb/07 seen in group of 5 with calf
- 29 May/07 seen with calf
- 5 March/08 seen with 2 bulls
- 29 May/08 not located
- 30 June/08 located, no visual
- 22 Oct/08 collar stopped satellite transmissions
- believe collar released from caribou March/09

Animal #111 (Sat, only VHF active)

- 3 March/05 collared
- 10 April/05 not checked on
- 5 May/05 seen in group of 2
- 31 May/05 seen with calf
- 10 June/05 not checked on
- 23 Sept/05 seen in group of 5 with calf
- 5 Oct/05 not checked on
- 1 March/06 seen in group of 9 without calf
- 29 May/06 seen with calf
- 16 Sept/06 seen in group of 3
- 24 Jan/07 seen in group of 14
- 27 Feb/07 seen in group of 4 with calf
- 30 May/07 seen with calf
- 4 March/08 seen in group of 8 with calf
- 28 May/08 seen with calf
- 11 Nov/08 collar stopped satellite transmissions
- 3 March/09 seen in group of 11 with calf

Animal #110 (died, Sat)

- 5 March/05 collared
- 10 April/05 not checked on
- 5 May/05 seen alone without calf
- 31 May/05 seen alone without calf
- 10 June/05 not checked on
- Died 5-11 June/05 likely wolf predation
- 29 July/05 collar retrieved

Animal #109 (died, Sat)

- 1 April/04 collared
- 29 May/04 no visual
- 3 June/04 not checked on
- 22 September/04 seen in group of 4 without calf
- 25 Jan/05 not checked on
- 31 May/05 seen with calf
- 19 June/05 seen with calf
- 23 Sept/05 no visual
- 5 Oct/05 seen in group of 3 with calf
- Died 22-25 April/06, likely wolf predation
- 23 Aug/06 collar retrieved

Animal #108 (Sat, observed alive, no Sat or VHF active)

- 1 April/04 collared
- 29 May/04 seen alone without calf
- 3 June/04 no visual
- 22 Sept/04 seen in group of 3 without calf
- 25 Jan/05 seen in group of 4 without calf
- 31 May/05 no visual
- 10 June/05 no visual
- 19 June/05 seen with calf
- 23 Sept/05 no visual
- 5 Oct/05 seen in group of 5 with calf
- 2 March/06 seen in group of 3 with yearling
- 30 May/06 seen with calf
- 23 Jan/06 seen in group of 5 with calf
- 27 Feb/07 seen in group of 11with calf
- 30 May/07 seen in group of 3 with calf
- 15 June/07 collar stopped satellite transmissions
- 3 March/09 seen in group of 3 with #146, no VHF active

Animal #107 (died, Sat)

- 1 April/04 collared
- 29 May/04 no visual
- 3 June/04 not checked
- 22 Sept/04 seen in group of 3 with calf
- 25 Jan/05 not checked
- Died 14-17 April/05 likely wolf predation
- 4 May/05 collar retrieved

Animal #106 (died, Sat)

- 30 March/04 collared
- 29 May/04 no visual
- 3 June/04 seen in group of 2 with calf
- 22 Sept/04 seen in group of 7 without calf
- 25 Jan/05 seen in group of 5 without calf
- 31 May/05 seen alone without calf
- 23 Sept/05 seen in group of 2 without calf
- Died 21-24 Nov/05, likely wolf predation
- 30 May/06 collar retrieved

Animal #105 (died, Sat)

- 30 March/04 collared
- 29 May seen in group of 3 with calf
- 3 June/04 not checked on
- 22 Sept/04 no visual
- 25 Jan/05 seen in group of 3 without calf
- 31 May/05 seen alone without calf
- 19 June/05 seen alone without calf
- 23 Sept/05 no visual
- 2 March/06 seen in group of 11 without calf
- 23 Aug/06 collar retrieved

Animal #104 (died, Sat)

- 29 March/04 collared
- 29 May/04 seen in group of 3 without calf
- 3 June/04 seen in group of 3 without calf
- 22 Sept/04 no visual
- 25 Jan/05 not checked on
- Died 19-27 April/05, death probably related to old age
- 4 May/05 collar retrieved

Animal #103 (died, Sat)

- 1 April/04 collared
- 29 May/04 seen in group of 3 with calf
- 3 June/04 not checked on
- 22 Sept/04 no visual
- 25 Jan/05 not checked on
- Died 25-30 April/05, likely wolf predation
- 4 May/05 collar retrieved

Animal #102 (died, Sat)

- 29 March/04 collared
- Died 14-15 May/04, wolf predation
- 3 June/04 collar retrieved

Animal # 101 (died, Sat)

- 30 March/04 collared
- Died during month of May/04, likely wolf predation
- 9 August/04 collar retrieved

Animal # 100 (Sat, no Sat or VHF active)

- 29 March/04 collared
- 29 May/04 seen in group of 3 without calf
- 3 June/04 seen alone without calf
- 22 Sept/04 no visual
- 25 Jan/05 seen in group of 11, without calf
- 31 May/05 seen in group of 3 with calf
- 19 June/05 seen alone without calf
- 23 Sept/05 a problem with VHF reception
- 30 Oct/06 a problem with satellite signal reception
- 6 Feb/06 no satellite/VHF signal
- 27 Feb/07 no visual
- 30 May/07 no visual
- 15 June/07 collar stopped satellite transmissions